WELCOME TO STEM INTEGRATION: Statistics is the Connection

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Why Integrate STEM?

“Scientists use technological tools to conduct experiments and mathematics and statistics to interpret the data produced by those experiments; engineers draw on scientific knowledge and mathematical reasoning to develop and model potential design inventions and solutions; technologists who build and maintain the products and systems designed by engineers must understand the scientific and mathematical principles governing their operation. And these professionals interact with one another in increasingly diverse and multidisciplinary teams.”

- STEM Integration in K-12 Education: Status, Prospects, and an Agenda for Research
  National Academy for Engineering and National Research Council
STEM Integration

- STEM integration does not encourage teaching the four disciplines as independent silos.
- All four STEM content areas will not be integrated into all lessons, all the time.
- Look for meaningful connections and mathematical topics which can be explored using natural phenomena or design challenges.
Why STEM and Statistics?

- STEM education is expected to lead to productive employment critical to our nation’s innovation capacity.
- A national demand exists for students with skills to fill data-intensive jobs.
- Statistical literacy is relevant to daily life.
- STEM literacy is essential to being a "smart consumer and thoughtful participant in democratic decision making and to making sense of the world more generally."

- National Academy for Engineering and National Research Council
Statistics Across the Curriculum

- Statistics provides opportunities to integrate with the social sciences
  - Comparing annual salaries for men and women in similar jobs
  - Investigating the likelihood of a particular candidate to win the election
- Many connections between statistics and science
  - Statistical problem-solving process is similar to the scientific method employed in inquiry models
  - Similarities in designing statistical studies and experimental design
  - *Analyzing and Interpreting Data* is a key NGSS practice
Big Ideas for lesson design

Statistics describe variability in data.

• Statistics can be used to compare two or more groups of data.

• Bivariate distributions describe patterns or trends in the co-variability of data on two variables.

• Inferential statistics uses data in a sample selected from a population to describe features of the population.

Source: Developing Essential Understandings of Statistics for Teaching Mathematics in Grades 6-8
Science vs. Engineering

**SCIENCE**

- Begins with a question about a phenomenon
- Ends with an explanation
- Scientists analyze data produced by investigations in order to provide meaning related to the question they are asking

**ENGINEERING**

- Begins with a problem or a need that can be solved using engineering
- Ends with a solution
- Engineers analyze data collected in the tests of their designs and investigations in order to refine their solution
Parachute Construction

Cut a square canopy to size.

Cut a length of nylon bead string to size and knot one end. Attach to a corner using a sticker dot.

Repeat for the other three corners.
Parachute Construction (cont.)

Measure desired length. Note: You may place a knot at desired length to mark location.

Gather suspension lines and tie to a jumbo paper clip at desired length.

Your parachute is ready for testing!
Parachute Testing

Place a glue dot in the top center of the canopy.

Attach to drop apparatus, if desired, or find a location to drop from a minimum height of 2 meters.
Station 1 – Vary Canopy Size

**Station 1 – Canopy Area vs. Hang time**

- With your partner, select a parachute canopy area to test from the brown bag.
- Using a square of canopy material, size your canopy to the correct area. The shape of the canopy should remain a square.
- To a corner of the canopy, you will attach a 40 cm pre-cut suspension line using a round sticker. Knot the end of the suspension line and place a sticker along a corner so that the knot is outside of the sticker.
- Repeat for the other three corners of the parachute.
- Bring all four suspension lines into the center and measure so that the suspension lines are 32 cm in length. Use the remaining length to tie a knot and attach one button plier clip as the load.
- Attach a glue dot to the center of the parachute canopy to attach the drop cord to the parachute as demonstrated by your teacher. Raise the parachute until the load is level with the 2 m line.
- Release the parachute and record the time until the load reaches the ground. Conduct three trials measuring hang time from a drop height of two meters.
Station 2 — Vary Suspension Line Length

- With your partner, select a parachute suspension line length to test from the brown bag.
- You will be making a parachute using a square canopy with a side length of 30 cm (canopy area 900 cm²) and a jumbo paper clip as the load.
- Cut four pieces of suspension cord at least 10 cm longer than your testable length to allow for attaching to the parachute canopy and tying together to attach the load.
- To a corner of the canopy, you will attach one suspension line using a round sticker. Knot the end of the suspension line and place a sticker along a corner so that the knot is outside of the sticker.
- Repeat for the other three corners of the parachute.
- Bring all four suspension lines into the center and measure the test length of each suspension line from the corner of the parachute. Use the remaining length to be a knot and attach a jumbo paper clip as the load.
- Attach a glue dot to the center of the parachute canopy to attach the drop cord to the parachute as demonstrated by your teacher. Raise the parachute until the load is level with the 2 m line.
- Release the parachute and record the time until the load reaches the ground. Conduct three trials measuring hang time from a drop height of two meters.
Station 3 – Vary Payload

- With your partner, select a payload weight to test from the brown bag.
- You will be making a parachute using a square canopy with a side length of 30 cm (canopy area 900 cm²), suspension line lengths of 30 cm, and a jumbo paper clip as the base load weight.
- To a corner of the canopy, you will attach a 40 cm pre-cut suspension line using a round sticker. Knot the end of the suspension line and place a sticker along a corner so that the knot is outside of the sticker.
- Repeat for the other three corners of the parachute.
- Bring all four suspension lines into the center and measure so that the suspension lines are 30 cm in length. Use the remaining length to be a knot and attach one jumbo paper clip as the base load.
- Add the number of metal washers as indicated on your test card to the paper clip.
- Attach a glue dot to the center of the parachute canopy to attach the drop cord to the parachute as demonstrated by your teacher. Raise the parachute until the load is level with the 2 m line.
- Release the parachute and record the time until the payload reaches the ground. Conduct three trials measuring hang time from a drop height of two meters.
Sample Data

- Canopy Area vs Hang Time
- Suspension Line Length vs Hang Time
- Payload vs Hang Time
STEM in this activity?

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How could we incorporate additional “engineering” into this activity?

- Design a parachute that maximizes hang time for a given mass (additional materials provided)
- Design a parachute that when dropped from a given height will land on a target within a given tolerance.
NOW DON'T TELL ME, WE MIXED UP OUR PARACHUTES?
Where to start?

- Investigate the CCSS for the middle-school statistics domain.
- Look for natural, physical, or technological phenomena or a design challenge applying the given mathematical concept.
- Determine relevant NGSS standards that could be integrated.
- Research topic or collaborate with peers!
- Determine access points to meaningfully integrate additional STEM concepts.
Data and STEM

- Design a package that could be used to safely ship a single potato chip through the mail.
- Design a device to measure wind speed and location and use the device to determine if it is safe for aircraft to land on various runways.
- Analyze streamflow data from hydrographs to predict floods, manage water allocation, and design and operate locks and dams.
Data and STEM

- Using the properties of reflection, design a “microwave transmission” network to send a signal from a source to a destination location.
- Use an air popper and different types of microwave popcorn to explore rates of popping and statistical distributions.
- Determine a location for a new hospital to minimize the drive times for patients using a neighborhood map.
Data and STEM

- Students can collect voltage and current data using different electric circuits to explore the idea of linearity using Ohm’s Law.

- Challenge students to use materials such as wire, iron cores, batteries, and objects to pick up to design an electromagnet that could pick up one ton of steel. (scale model)
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